Statistical Analysis of 2n and 4n Pollen Formation in Lolium perenne Using Pollen Diameters

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STATISTICAL ANALYSIS OF 2N AND 4N POLLEN FORMATION IN LOLIUM PERENNE USING POLLEN DIAMETERS

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It is a well-known feature that pollen size increases with ploidy level. Therefore, screening for genotypes that are able to produce 2n and 4n pollen can be based on differences in size of n, 2n and 4n pollen (Veronesi et al., 1988). A typical data set consists of measurements of pollen diameters presented in tables of observed frequencies or in histograms. Usually such a histogram shows an unimodal but skewed distribution of the data. One or more of these histograms together may suggest the presence of 2n or 4n pollen. A small data set, five samples from one and the same plant of Lolium perenne, is used to show the statistical analysis of such data (Fig. 1).

Mixtures of two, three and four normal densities were fitted to the logtransformed data. It appeared that the observed and estimated frequencies were very close for mixtures of three or four components (Table 1). The estimated mean values for the first three components correspond to pollen volumes in the ratio of 1 : 1.9 : 3.6. Therefore these components probably correspond to n, 2n and 4n pollen (Table 2 and Table 3). The fitted component densities as well as their mixture density are superimposed on the histograms (Fig. 1). The fourth component is solely due to the three smallest observations in the fifth sample, which represent probably letal micropollen.

The large variation in 2n and 4n pollen proportions between the five samples suggests a strong effect of environmental factors on 2n and 4n pollen production. Therefore, extreme caution should be taken in defining genotypes as 2n or 4n pollen producers.

Crude estimates of the proportions of 2n and 4n pollen can easily be obtained by the method proposed by Veronesi et al (1988). Therefore this method may be useful in breeding programs. The present method yields a more accurate analysis of the data by taking into account the pollen distribution (lognormal), the experimental design (samples), and the method of data collection (rounding). Inference on the number of components can be made using χ^2 tests for goodness of fit. The present method will be especially valuable for the analysis of experiments designed to study effects of factors (e.g. genotype, temperature, or age of the plant) on 2n and 4n pollen formation.

References

Veronesi F., Mariani A., Tavoletti S., 1988. Screening for 2n gamete producers in diploid species of genus Medicago. Genet. Agr. 42: 187-200.

Table 1. χ^2 test for goodness of fit of different numbers of components in the pollen mixture.

Number of components in the mixture	Degrees of freedom	χ^2 test statistic	Critical values (α = 0.05)
1	37	341.5	51.9
2	33	55.5	47.1
3	31	42.2	44.7
4	30	13.7	43.4

Table 2. Estimated proportions.

	Ploidy level		
Sample	n	2n	4n
1	0.91	0.09	0
2	1	0	0
3	1	0	0
4	0.12	0.69	0.19
5	0	0.98	0

Table 3. Estimated mean values.

	Ploidy level		
Sample	n	2n	4n
1	13.4	16.6	-
2	13.9	-	-
3	14.3	-	-
4	13.2	16.4	20.3
5	-	16.3	-

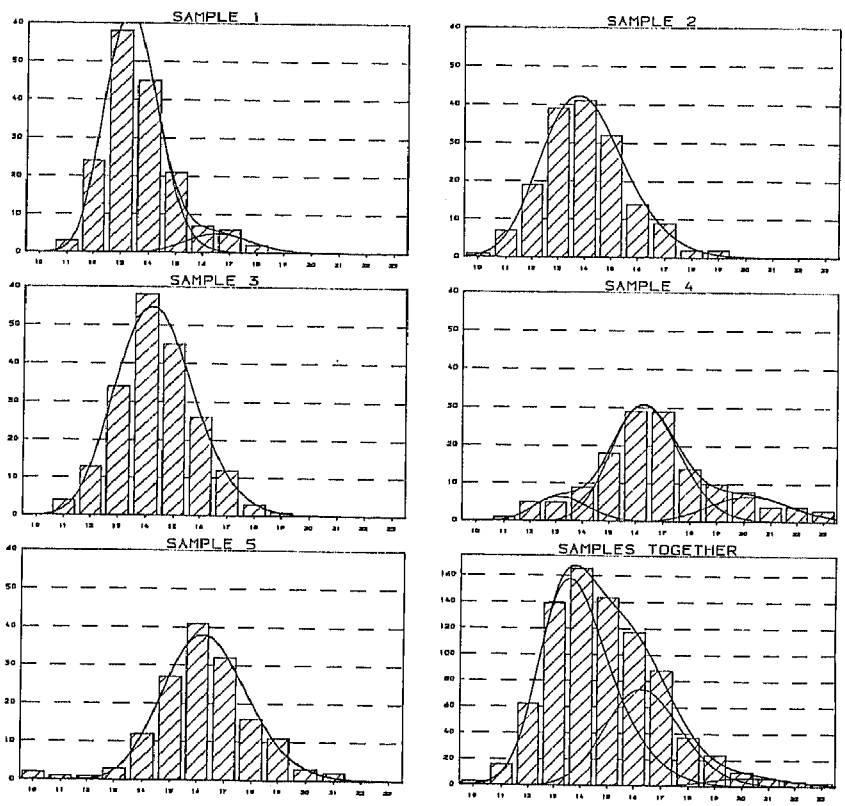

Figure 1. Histograms of the data and graphs of the n, 2n and 4n pollen densities and their pollen mixture density.